

4.1
Rates of Deforestation

Tropical deforestation was a concern to colonial powers in the 19th century, because of their reliance on the forests of their colonies to supply timber for building naval vessels. For example, British Colonial Foresters became concerned with the lack of regeneration of teak forests in Burma (now Myanmar) and initiated a reforestation program in the mid-1800s (Takeda 1992). However, global concern over tropical deforestation did not begin until the mid-20th century. Following World War II, logging increased in intensity and scale, and population pressures in tropical countries resulted in the clearing of tropical forests for agriculture. By the 1960s, scientists began to recognize that the disappearance of tropical forests represented an important loss of global resources, and in the 1970s and 1980s began to determine the area of tropical forests worldwide and the rate at which they were disappearing (Table 4.1).

The estimates varied widely due to a number of factors. First, boundaries of forests are not always well delineated. Along a climatic gradient, density of trees may gradually decrease. For example, a gradient could begin with a forest with a closed canopy that transitions to a savanna with open spaces between trees; the savanna gives way to a grassland or shrubland. Different

Table 4.1. Estimates of the global area of tropical moist forest, and rate of deforestation from the 1970s to 1990. Values for area are in millions of hectares. Rate of deforestation is in millions of hectares per year. (Adapted from Grainger 1993; Pearce and Brown 1994; Achard et al. 2002)

Period	Area of forest	Area deforested/annum
1970s	935–972	7.5–20
1976–1980	1,081	6.1
Late 1980s	800	14.2
1981–1990	1,282	15.4–16.8

authors may delimit each forest type differently. Most studies have limited their estimates to “moist” forests, probably upland moist forests (Table 4.1). Other types of moist forest such as swamps, given in Table 3.3 (Chap. 3), would not be included if some of the data in Table 4.1 were limited to upland moist forests. Exclusion of open forests or dry forests results in further discrepancies. The pre-1990 estimates for forest cover in Table 4.1 are low compared to the estimates in Table 4.2, because the latter includes dry deciduous forests (forests with greater than 4 months’ dry season and that lose all their leaves during that time).

Another problem with data on extent of forest cover and rates of deforestation is that, in many cases, values for individual countries are obtained from documents prepared by local authorities who often rely on maps drawn by field workers with little training. The authorities themselves may have political motivations for either exaggerating or under-reporting the extent of forest cover. Often maps are not available for all tropical countries or all regions within a country and estimates may be based upon extrapolations from available sources.

The more recent data of Achard et al. (2002; Table 4.3) were derived on a global basis from satellite imagery, but with varying degrees of resolution.

Table 4.2. Estimate of areas and rates of deforestation of all tropical closed forest, all open tropical woodlands, and the sum of the two, in 1980. Values for area are in millions of hectares. Rate of deforestation is in millions of hectares per year. (Adapted from Grainger 1993)

	Latin America		Africa		Southeast Asia		Total	
	Area	Rate	Area	Rate	Area	Rate	Area	Rate
All closed forests	679	4.1	217	1.3	306	1.8	1201	7.3
Open woodland	217	1.3	486	2.3	31	0.2	734	3.8
Closed plus open	896	5.4	703	3.6	337	2.0	1935	11.1

Table 4.3. Estimate of area of tropical moist forest by continent, and rate of deforestation between 1990 and 1997. Values for area are in millions of hectares. Rate of deforestation is in millions of hectares per year. (Adapted from Achard et al. 2002)

	Latin America	Africa	Southeast Asia
Forest cover, 1990	669	198	283
Forest cover, 1997	653	193	270
Area deforested/annum	2.5	0.85	2.5
Annual percent loss	0.38	0.43	0.91
Area of regrowth/annum	0.28	0.14	0.53

Fearnside and Laurance (2003) have criticized the Achard et al. (2002) data on the basis that it did not include dry forests; estimates on biomass were based on data from a single site; it failed to include palms, vines, and understory vegetation; and erroneously assumed that secondary forests would regenerate 70% of their biomass in 25 years. This may account for the relatively low rate of deforestation reported in Table 4.3.

The World Resources Institute (2004) presents data from the US Geological Survey's Earth Resources Observation System on forest coverage in 1993 (Table 4.4). In their data, evergreen broadleaf forests are those that have a percent canopy cover greater than 60%, and almost all trees remain green throughout the year. Deciduous forests have canopy cover greater than 60% with annual cycles of leaf fall. Estimates diverge somewhat from those in Tables 4.2 and 4.3, but differences may be due to different systems of classification. The largest discrepancies are for Africa. The evergreen and deciduous forests for Africa shown in Table 4.4 do not include the open woodland shown in Table 4.2.

A further problem is simply defining what constitutes "deforestation". Does a trail made by loggers to extract one mahogany tree constitute deforestation? Does the clearing made by one shifting cultivator who enters the forest by that trail qualify? When loggers remove many of the trees, but leave some individuals still standing, is the area deforested? As the peasant farmers stream in and lay claim to the land, eventually it does become "deforested". What percentage of cover removal constitutes "deforestation?" Determining the point at which closed forest becomes deforested is quite arbitrary.

Further complicating the problem is the fact that there are many areas, as in the eastern Amazon region, where deforested land has been abandoned and is growing back into secondary forests (Dubois 1990). These stands are comprised of species different from those in closed, primary forests. Should the areas of these recovering forests be subtracted from the areas of primary forest that is cleared? Plantation forests growing on previously deforested land present the same question.

Laurance et al. (1997) pointed out that there is an increase in biomass loss in forest fragments, due to the fact that along fragment edges, microclimatic

Table 4.4. Tropical forest cover in 1993 characterized from 1-km advanced very high resolution radiometer data (USGS 2004). Values are in millions of hectares

	Latin America	Sub-Saharan Africa	Southeast Asia
Evergreen broadleaf	784	350	200
Deciduous	47	14	–
Total	831	364	–

changes and elevated wind turbulence cause increased tree mortality. Such edge effects increase exponentially as the area cleared increases linearly. Losses due to edge effect would not be detected by satellite reconnaissance, and probably not even by conventional land-based mapping techniques. Laurance and Fearnside (1999) further suggest that losses may be increasing. They stated that “Despite initiatives to reduce deforestation, in 1998 the rate of forest loss in the Brazilian Amazon rose by nearly 30% over the preceding year – not including the extensive areas degraded by ground-fires, logging or habitat fragmentation”. Consequently, rates of deforestation may be greater than those reported in Tables 4.1–4.3.

Despite the problems of assigning accurate numbers to deforestation rates and biomass changes, the data suggest regional trends. From 1990–1997 Latin America and Southeast Asia had similar rates of deforestation in terms of area cleared. However, because in Latin America there is a much greater area of moist forest, percentage loss is lower (Table 4.3). The rate of loss in open woodlands of Africa is relatively high, but Africa has considerably more open woodlands than closed forests, and more open woodlands than the other two continents (Table 4.2).

4.2

Causes of Deforestation

4.2.1

Proximate Causes of Deforestation

4.2.1.1

Expansion of Agriculture

Myers (1984) cited “shifting cultivation” as the most important cause of deforestation. There are various types of shifting cultivation. A destructive type of shifting cultivation is practiced by non-indigenous colonizers who often know little about farming, other than chopping down the forest, burning it, and planting corn or rice in the ashes. After 2 or 3 years, production gives out, and they are forced to move further into the wilderness. They may just abandon the land, or they may sell their land to a consolidator, perhaps a rancher, who is buying up land in the region, either for pasture or for speculation. In Brazil, some of these shifting cultivators are from the drought-ridden north-east and have migrated into the Amazon rain forest and cleared small patches for agriculture. Although they may follow roads built by the government or by loggers, they act on their own. Other colonizers may be participants in a government resettlement program, in which people from other regions of the country, including cities, are transported to wilderness

areas and given some land and subsidized housing. Myers (1992) referred to this type of shifting cultivation as “*shifted* cultivation”, i.e. practiced by people who would not be farmers, given the choice, in contrast to “*shifting* cultivation”, practiced in a more “traditional” fashion. In the 1980s and 1990s, “shifted” cultivation apparently accounted for 35, 70, and 50% of deforestation of closed forests in America, Africa, and Asia, respectively.

Cultivation of illegal narcotic plants such as coca (the source of cocaine) and opium (the source of heroin) in rain forest clearings in Southeast Asia and South America is also a destructive type of shifting cultivation. When the plots are discovered by drug enforcement agents, the farmers move elsewhere.

Another type of shifting cultivation has been practiced by indigenous peoples for subsistence and by people whose ancestors moved into the forest and learned traditional techniques. A small area, approximately 1 ha, is cleared and then burned. Both annual crops such as manioc and perennial crops such as fruit and nut trees are planted. The annual crops produce well for 1 or 2 years, but declining nutrient availability and weed pressure rapidly diminish the production by annuals. However, by the third year, perennial crops such as plantain and cashew have become established and begin to yield. Successional species that are valuable for wood, medicines or other uses are favored, and other species may be weeded out.

In some areas, people who have lived in the forest for generations follow this same system. This system can be sustainable, as long as population density is low, because the land can be left fallow long enough to recover soil fertility. Organic debris from the surrounding forest quickly covers the soil, either directly through leaf and litter fall or through dispersion by animals. It is the organic matter that keeps the nutrients available in most tropical soils. When the plot is left fallow, the soil organic matter gradually builds up again, and the nutrients, especially phosphorus, become available (Jordan 1995 a). Some tribes, like the Kayapó in Brazil, plant perennial crops and fruit trees in the fallow, managing the plot as a long-term rotation (Posey 1982).

The length of time required for the site to regenerate sufficient nutrients to permit further cultivation depends on the soil quality and the intensity of cultivation, and can vary from a few years to almost a century (see also Chaps. 2 and 5). Younger, volcanically derived soils, for example, regenerate more quickly than highly weathered Oxisols of the lowland tropics. As forest areas become more populated, the fallow period becomes shortened. Because of the short fallow, nutrient stocks in the soil do not fully recover, and the period of cultivation must be shortened (Nye and Greenland 1960).

Permanent cultivation has become a more important cause of deforestation than shifting cultivation (Geist and Lambin 2002). In South and Central America, large areas of forest have been converted to pasture. Mega-farms that produce soybeans are encroaching on the southern fringes of the Amazon rain for-

est (Nepstad et al. 2002). Tree-crop plantations for rubber, oil palm, cocoa, coffee, and coconut have been an important cause of deforestation in Africa and Southeast Asia (Grainger 1993). In Central America, plantation crops such as coffee, cacao, palm oil, bananas, pineapple, and others have also been a major force driving deforestation. Timber is another key plantation crop. In the Jarí project in the state of Pará in Brazil in the eastern Amazon, tens of thousands of hectares of primary forest were cleared in order to plant the fast-growing species *Gmelina arborea* for pulp wood (Jordan 1995b). Commodity crops such as those mentioned above are subject to global economic cycles of boom and bust. When demand peaks, deforestation occurs as land is cleared for new plantings. When oversupply occurs, cleared land is often abandoned.

Tropical agriculture is not necessarily ecologically or economically unsustainable. The colony at Tomé Açu in the state of Pará, Brazil, is an interesting example of colonizers who learned to farm sustainably on the poor soils of the Amazon. Japanese immigrants in the 1920s settled the area and experimentally devised a rotational scheme that included mixtures of perennials and annuals, and various animal stocks to supply manure as well as meat and milk (Subler and Uhl 1990). Because of the diversity of their agricultural practices and products, their soils retain fertility and their economic income is less influenced by global cycles that affect individual commodities.

Ranching

Conversion of tropical forest to pasture has been a particularly important activity in Brazil. In the late 1970s, the Brazilian government instituted a program to encourage ranching in the Amazon region. Large cattle enterprises were promoted as the prototype for development. There was a perception that ranching actually improved the quality of the soil by increasing soil nutrients (Barbosa 2000). However, the soil tests that led to this conclusion presumably were taken immediately after the cutting and burning of the forest, before the ashes containing the nutrients had leached away (see Figs. 2.10–2.12 for nutrient dynamics following burning of forest, and see Fig. 2.13 for changes in the availability of soil nutrients following conversion of forest to pasture in the Amazon region of Brazil). Roughly 10 million ha of land was converted from forest to pasture by the early 1980s (Hecht 1985). Since then, government incentives to clear forest have been reduced, but conversion of forest to pasture still remains important in the Amazon region (Castellanet and Jordan 2002).

4.2.1.2

Wood Extraction

Wood has always been an important fuel for forest dwellers, and even in the mid-20th century 80% of all wood harvested was for fuel (see Chap. 1). Commercial loggers in the tropics concentrated only on a few valuable timber species such as teak and mahogany. Following World War II, woods of lighter density were also extracted to be sold in national or foreign markets. From 1950–1980, tropical hardwood exports rose 14-fold, from 4.6 to 61.2 million m³ of roundwood per year (FAO 1989; see also Chaps. 1 and 6).

In the 1990s, there was a dramatic increase in logging in the tropics. In many developing nations, tariffs and trade barriers fell, while new international free-trade agreements promoted foreign investment, particularly in natural resource-based industries such as timber (Laurance 2000). Each year, approximately 6 million ha of tropical forest was logged (Whitmore 1997). Although only between 2 and 40 trees may be harvested per hectare, 10–40% of the remaining forest biomass is killed or severely damaged during logging operations (Uhl et al. 1991; Verissimo et al. 1992). The main damage results from the labyrinth of roads, bulldozer trails, and small clearings in the forest. The heavy machinery kills many smaller trees, damages and compacts the soil, and increases soil erosion and stream sedimentation (see also Chap. 5). A study in Indonesia found that even though only 3% of the trees were cut, the logging operation damaged 49% of the trees in the forest (Urquhart et al. 1998). Once opened, the forest is increasingly vulnerable to hunters, ranchers, and shifting cultivators (Wilkie 1992). Logging also increases the vulnerability of forests to fire by rupturing the forest canopy and creating piles of dry, flammable debris. In the Amazon and Borneo, millions of hectares of logged forest were destroyed by wildfires during the 1982–1983 and 1997–1998 El Niño droughts (Brown 1998; Laurance 1998).

4.2.1.3

Development of Infrastructure

The settlement and subsequent clearance of frontier lands in Latin America have closely followed the expansion of the road network. Road building is not always carried out exclusively by governments. In Ecuador, the early penetration roads into the environmentally fragile eastern region were largely built by multinational oil companies. Mahar and Schneider (1994) argue that road building is the single most powerful factor causing the deforestation of frontier areas in Latin America. Certainly oil exploration, agricultural expansion, and timber extraction are not possible without roads, and they are important reasons why roads are built in many forest regions.

The results of providing all-weather overland access to frontier areas are often cumulative and irreversible. The increase in population associated with the completion of primary roads usually generates demand for secondary and feeder roads, which in turn attract more population. The process has been documented throughout the Brazilian Amazon, in the eastern lowlands of Ecuador, Peru, and Bolivia, as well as in Central America. Once roads have been built into wilderness areas, there is pressure on the local and national governments to provide further infrastructure such as health services, education, police, and other social services (Castellanet and Jordan 2002).

4.2.2

Underlying Causes of Deforestation

Agriculture, ranching, timber extraction, road building, and mining are only the proximate causes of deforestation (Geist and Lambin 2002). These activities are necessary for human survival, but individuals cannot easily undertake them on their own. There have to be institutions that make these activities feasible, and forces that drive people and institutions to undertake them. These institutions and forces are the underlying causes that drive tropical deforestation and can be separated into five major categories (Fig. 4.1). They are presented here in order of decreasing importance as listed by Geist and Lambin (2002).

4.2.2.1

Economic

The economic development on forested frontiers often follows a pattern that is exemplified by the region west of Belém, Pará, on the eastern edge of the Amazon rain forest (Jordan 2001; Fig. 4.2). In this figure, the horizontal axis is the distance from a particular piece of land to markets for agricultural products or beef. In the eastern Amazon region, the city of Belém is a traditional market and the town of Paragominas is becoming one. “Distance from markets” not only implies the actual linear distance, but also includes the logistical difficulty of getting supplies from the market and taking the produce to the market. A farm 100 km from the market on a paved road is logistically closer to the market than a farm 40 km away on a dirt road that becomes impassable during rainstorms. “Net present value” of the land is simply its current market price. Net present value is determined in part by the value of the labor necessary for economic income; the cost of defending property rights to that land; the value of the capital necessary to produce an economic income; and the equilibrium price of the land, that is, what bidders in the market place will pay after consideration of other factors.

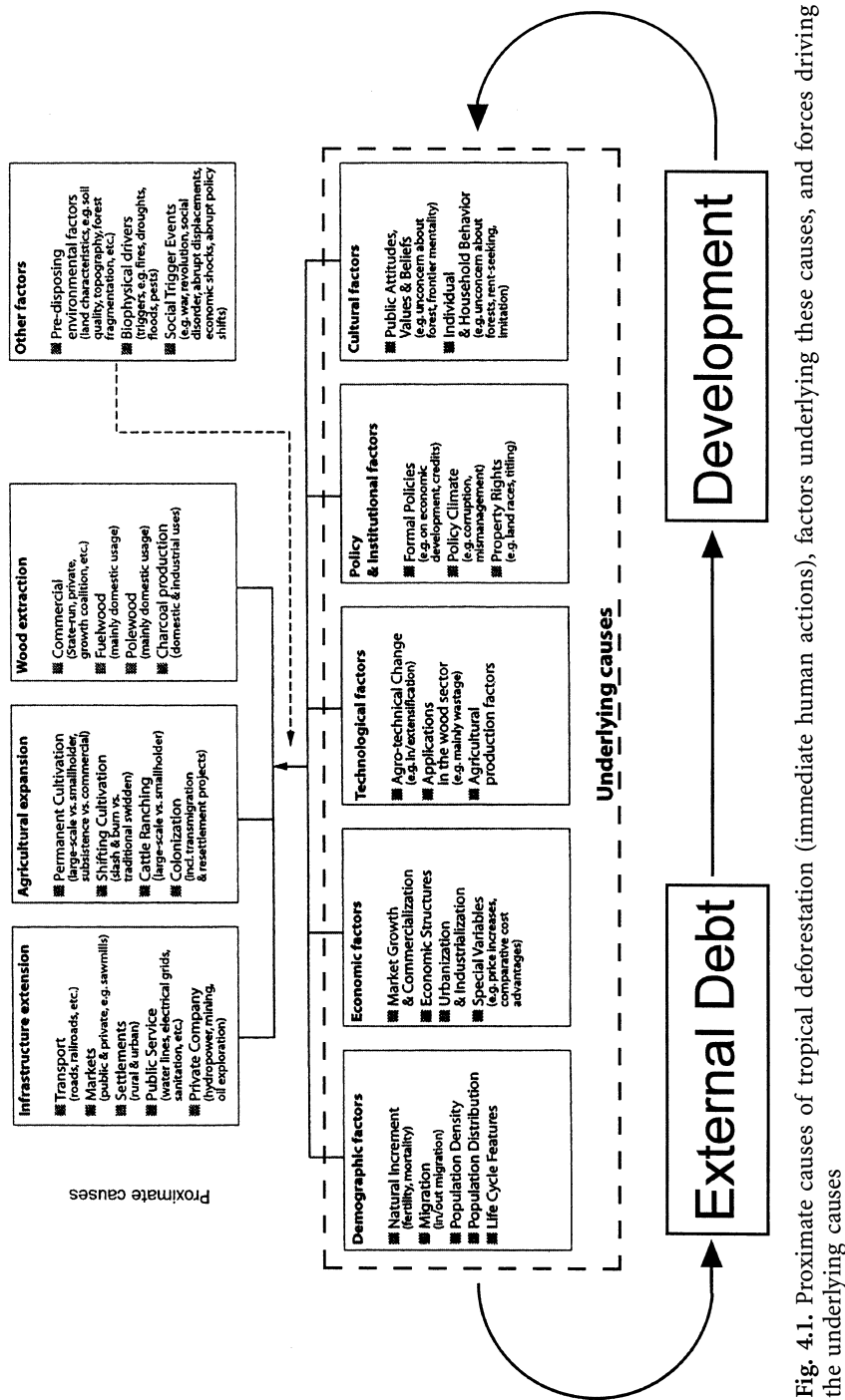


Fig. 4.1. Proximate causes of tropical deforestation (immediate human actions), factors underlying these causes, and forces driving the underlying causes

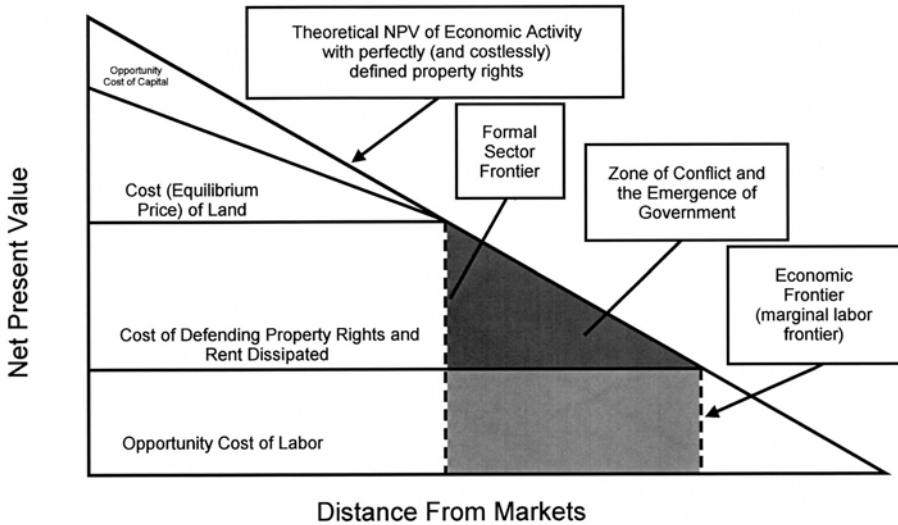


Fig. 4.2. Economic value (*NPV* net present value) of a parcel of land on the frontier as a function of distance from markets where products from that parcel could be sold. (Adapted from Schneider 1995)

Economic frontiers are those areas most remote from markets. Often these are settled by landless peasants who practice shifting cultivation. Such areas are not only distant from markets but also distant from any type of infrastructure such as roads, railroads or small cities. Even if the land is legally owned by a corporation, an individual investor or by the government, the land is essentially “free” to the peasant. The cost of keeping out the squatters is more than the land is worth to the official owners. The only cost to the peasant in such areas is his and his family’s labor.

As infrastructure begins to develop in such regions, the logistical “distance” to markets begins to decrease, and we enter the “zone of conflict and the emergence of government”. As a road is built across a region, property rights begin to be an issue. If the land officially belongs to someone or some institution, they may try to evict the squatter, either forcibly or through negotiations. Obtaining a legal title to a piece of land through “squatter’s rights” requires an investment of time and money on the part of the peasant, and many prefer to sell their “rights”, or just to give up and move on to the next frontier. Land is given up or sold not for ecological reasons of decreasing productivity (although that may be a factor), but mainly owing to economic considerations. Often, land is bought up by speculators or by companies engaged in speculation hoping to profit from the increase in value brought about by increasing governmental infrastructure in the area (Schneider 1995).

New capitalist owners of the land often do not begin managing their land right away. Costs of importing fertilizers, herbicides, etc. and of exporting crops are still too high for the landowner to use the land profitably. The landowner assumes, however, that the government will eventually build and improve roads into the region, and establish governmental services such as health care, schools, and market support in local villages. Meanwhile the land lies abandoned.

Usually substantial government services do emerge in a frontier region. As a result, the logistical distance to an existing market decreases, or a new market may emerge. At this point, it becomes worthwhile for the owner to begin investing in infrastructure and supplies that will cause the land to yield a profit. The investor may build a ranching complex or a farm, buy trucks and tractors, hire labor, and import agricultural chemicals. At first, profits are small, but as transportation logistics improve, and the market becomes larger and more economically diversified, profits increase. Because the operation is logistically close to the market, transportation costs fall, and the entrepreneur can successfully compete in the emerging market against producers in other regions. Profitability on lands close to the markets is increased by intensification and by specialization. This is not a phenomenon exclusive to the Amazon. Rather, intensification and specialization have been the essence of development in all regions of the world (Barbosa 2000).

4.2.2.2

Political and Institutional Factors

Geopolitical

Geopolitical concerns are often a reason for opening up a frontier, when national boundaries are ill-defined, or territories are threatened. During the rubber boom of the late 19th century, the westernmost region of the Amazon lowlands was disputed between Brazil and Bolivia. Frustrated by the inability of both countries to reach an agreement on their future, people in the region declared their independence from both countries, creating the independent state of Acre (Barbosa 2000). The newly independent state, composed primarily of Brazilians, managed to expel the Bolivians from the area, thus opening the door for Brazil's de facto control. Despite the fact that Brazil was the imperialist power in this case, the possibility of Bolivia reclaiming the region for itself played on Brazilian insecurities.

In the 1970s, the Superior War College of Brazil was influential in promoting a policy for populating and integrating Amazonia with the rest of Brazil. The view was that development policy should follow the geopolitical needs of the country, that is, the population vacuum in the interior should be filled, as a protection against groups who were said to be "communist guerrillas". The

reality was, however, that these were local groups protesting the military dictatorship of Brazil, but that was all the more reason for the military to create a series of agencies responsible for development of the country. For Amazonia, the main agency was the Superintendence for the Development of the Amazon (SUDAM). The responsibility for forest protection came under the Brazilian Institute of Forest Development (IBDF), and indigenous people's affairs came under the National Indigenous Foundation (FUNAI). However, these agencies were compliant when powerful interests demanded the clearing of forests or the removal of indigenous peoples. Things began to change as a result of the re-establishment of democracy in the mid-1980s. The new civil liberties allowed indigenous peoples to organize and form coalitions with environmentalists and grassroots organizations within Brazil and abroad. Central to this change has been the participation of a free Brazilian media eager to cover events taking place in Amazonia, sparked to a large extent by national and international interest over the fate of the forest (Barbosa 2000).

Land Tenure

Land tenure policies that give settlers the right to land only if the forests are cleared stimulate deforestation. In many tropical countries, forest clearing is considered to be an activity that "improves" the land, and lack of improvement indicates that the settler has no interest in the land, or is incapable of using it "productively". A common tactic in the Amazon to ensure tenure is to clear a large area of forest, burn it, put a strand of barbed wire fence around it, and stock it with a few head of cattle. There is no expectation, however, on the part of the settler to make any money from the cattle. Rather the expectation is that the land will be sold at a large profit after the government extends roads and facilities into the region (Schneider 1995). Land speculation, especially by corporate ranches, still occurs in the Amazon (Smouts 2003). In the Malaysian state of Sabah, laws dating from the British colonial period make the state government the holder of all forestry property rights, but permit any native person to obtain title to forest land by clearing and cultivating it. In the Philippines, land claims predicated on forest clearance involved not only small-scale shifting cultivators, but also extensive live-stock operations (Repetto 1988). In recent years, as a result of the disappearance of the forest frontier in the Philippines, agricultural intensification has become more important than land clearing (Coxhead et al. 2001).

Tax Policies That Encourage Deforestation

A variety of government policies (investment incentives, credit concessions, tax provisions, agricultural pricing policies, and the nature of lease or sale of forest exploitation rights) create incentives to engage in faster deforestation. Such policies are often instituted when the free market does not accomplish geopolitical goals in frontier regions at a fast enough rate. For example, when the Brazilian

government in the early 1970s wanted to open up the eastern Amazon region, officials in charge of regional planning and local financial institutions made considerable effort to convince entrepreneurs to invest in the region. Livestock production was publicized as the most promising investment in part because of national demand and because it seemed to carry little risk. Ranching received the highest priority ranking of projects by government agencies, but among ranchers and corporate groups, livestock was recognized as an only marginally profitable enterprise. However, the enormous gains in land value and the use of incentive monies and reductions or elimination of taxes made clearing of forest for ranching a sound financial option (Hecht 1982). As a result of international pressure to conserve rain forests, Brazil reduced or eliminated many tax benefits deriving from deforestation. However, ranching has not declined in importance because cattle production has become increasingly profitable due to improvements in technology, such as grasses that respond well to fertilization (Cattaneo 2001).

Lack of Enforcement of Environmental Laws

While many developing countries have environmental laws to regulate logging, the laws are often weak and have poor enforcement (see case study below on Indonesia). As a result, there has been a recent dramatic increase in foreign investment in tropical logging by companies to take advantage of this situation (Laurance 2000).

The Transmigration Program in Indonesia (Box 4.1) is an example of how several political and institutional factors interact to cause deforestation.

Box 4.1

The Indonesian transmigration program (World Bank 1988; Muntingh 1997; Katoppo 2000; Kusumaatmadja 2000; Fuller 2003)

Resettlement programs were begun in Indonesia in 1905 when Indonesia was under Dutch rule. Because there were high population densities on some islands and sparse populations on others it was believed the resettlement programs would result in better conditions for both the source and the receiving islands.

Beginning in 1979, the scale of the transmigration program significantly increased, from about 52,000 families during the previous 5 years to 366,000 families during the subsequent 5-year period. Movement was chiefly from the overcrowded islands of Java, Madura, Bali, and Lombok to the largely forested islands of Sumatra, Kalimantan, Sulawesi, and Irian Jaya. An important reason for the transmigration program was the limited land available for farming. In Java, most farming families had less than half a hectare of agricultural land. Farmers had to move onto steep slopes and into forest reserves, where cultivation and erosion caused environ-

mental degradation, siltation of reservoirs, and flooding. Urbanization in Java's major cities was occurring at more than 4% per year, resulting in about 1.6 million new residents each year.

Transmigrants were recruited in rural areas. They were required to be married, to be "of good character", and to have had previous farming experience. Migrants were moved by plane or bus, and on arrival at the receiving island they were given a small house on 0.25 ha of village land and 1 ha of cleared land outside the settled area. In addition, they were supplied with planting materials for minor tree crops such as coffee and small livestock. Public facilities including schools and clinics were provided in the village center. Subsistence supplies were provided for 1 year while the land was tilled and crops established. Settlements were expected to be self-sufficient at the end of 5 years.

In 1985, the World Bank, which helped finance the transmigration program, initiated a review of the resettlement program. Their report noted serious deficiencies. Land clearing was often of poor quality, road construction and maintenance standards were low, and the supervision of contractors uneven. Land for settlement became difficult to find, and land for large-scale settlements in Sumatra was virtually exhausted. The provision of agricultural supporting services, including input supply, extension, and credit, was inadequate, and no progress was made on programs to introduce tree crops to existing settlements. Institutional arrangements for coordination, planning, budgeting, and monitoring and evaluation were weak. The most sensitive issues were social and environmental. Rapid land clearing without adequate planning led to conflicts between transmigrant colonists and local people. Deforestation was also noted as an increasing problem. In January 1986, the government of Indonesia made significant reductions in all development budgets in response to declining oil revenues. In May 1986, the budget was further reduced to 38% of the previous year's figure. It was assumed that most of the transmigration in future years would be from unassisted migrants.

At the time that the transmigration program was expanding, concessions were increasingly granted for logging in the outer islands. Through road building, the transmigration program was instrumental in opening up the outlying islands to exploitation and environmental damage. In 1997, huge forest fires raged across Borneo (Kalimantan). Muntingh (1997) detailed how the fires were caused in part by logging companies acting illegally. Logging continued unchecked, even in designated conservation areas, by concession holders linked to the timber industry and politicians. Substances used in the preservation of logs polluted the rivers and water supply, leading to the death of fish and protected animals, including orang-utans and bears.

Logging and its aftermath severed traditional peoples' ties with their customary land, undermined their sense of identity, eroded their religious and cultural framework, and created great disorientation. Traditional communities became alienated and cultural degradation was manifested in violence. In September 1999, an Update Conference on recent developments in Indonesia was held at the Australian National University that reported on the environmental and social developments during the previous decade. The country had become subjected to a regime of "runaway rent seeking, crony Capitalism (contracts given to old friends, sometimes called 'cronies', and relatives instead of opening bids to the free market), nepotism, and blatant corruption". As public outcry increased, the government responded with increased repression. Environmental rules were disregarded, warnings were ignored, and international protests were unheeded as major companies with close links to highly placed officials began to invest in large-scale agribusiness ventures, such as oil palm plantations. Land clearing was carried out during the worst drought in 50 years. An area of 1.7 million ha of forested land was lost to fire. Other costs due to the massive burning included haze-related losses in the transportation sector, disruption to the distribution system, and long-term health consequences to 20 million people exposed to thick haze for over 4 months in Sumatra and Kalimantan. The increasing population in Indonesia's outer islands continues to threaten forests and their wildlife.

A recent study based on satellite and field-based analysis (Curran et al. 2004) has reported that between 1985 and 2001, Kalimantan's lowland dipterocarp forests that had been designated "protected areas" declined by more than 56% ($>29,000 \text{ km}^2$). Deforestation resulted primarily from intensive logging by timber concessions, followed by the clear-cutting of residual stands for oil palm plantations. Threatened nomadic and large vertebrates with extensive lowland ranges are predicted to decline precipitously, especially carnivores, ungulates, and primates (e.g. the Malayan sun bear *Helarctos malayanus*, the bearded pig *Sus barbatus*, and the orangutan *Pongo pygmaeus*). Curran et al. (2004) concluded by citing a World Bank report that indicates that rate and extent of loss of lowland protected forest area in Kalimantan far exceed previous projections. Stemming the flow of illegal wood from Borneo requires international efforts to document a legitimate chain-of-custody from the forest stand to consumers through independent monitoring.

4.2.2.3

Technological

Deforestation increases as the technological means to do so become more available (e.g. chain saws, bulldozers, tractors). At the Jarí plantation in the state of Pará in the Brazilian Amazon where the native forest was replaced with plantations of fast-growing tree species, a more efficient way of getting rid of the native forest was needed. The solution was to fasten a chain to two giant bulldozers, a hundred meters apart. As the bulldozers plowed in parallel lines through the forest, the chain pulled down all the trees in the path (C.F. Jordan, pers. observ., 1984).

The development of agricultural technologies also has contributed to deforestation. Early supplies of palm oil, used to make margarine, cooking fats, and soap came from wild oil palm trees in the rain forests. However, as demand increased, forests were cleared, especially in Southeast Asia, for palm oil plantations. Large monoculture plantations linked to nearby processing plants are needed for efficient production. A typical estate in the Malaysian state of Sabah has five 1,000- to 2,000-ha plantation units plus workers' quarters (Grainger 1993).

4.2.2.4

Cultural

Cultural causes of deforestation include attitudes, values, and beliefs toward publicly owned properties, or toward resources that are perceived as being free. Many tropical forests are publicly owned, that is, they belong to the national government. People living in or near the forest often have a tradition of using the forest for their livelihood, and perceive their use of the forest as an inalienable right. Their ancestors have used the forest for generations, and the knowledge of how to use the forest and the biota that it contains is part of their cultural heritage.

Use of publicly owned resources becomes a problem when the demand for those resources exceeds the capacity of the environment to produce them. Hardin (1968) used the phrase "the tragedy of the commons" to encapsulate what can happen when commonly owned resources are overexploited. "Ruin is the destination toward which all men rush, each pursuing his best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all" (Hardin 1968, p. 1244). This thesis has been criticized because the access to many commons is not open to all, but limited, either by social pressure or legal restraint, to specific groups (Acheson 1987). However, forests in much of the tropics are, in fact, of open access. Most governments do not have the ability to protect these resources, so, in effect, they are free

for the taking. While there are often governmental rules regulating the cutting of forests, they are difficult to enforce, and the common perception is that they will not be enforced.

The exploitation of the forest commons by traditional peoples is a cultural trait. However, their use of “free goods” leads to what could be called a feeding frenzy. Ranchers, loggers, miners, speculators, and shifting cultivators, once they see that others have access to the forest, reason that they also should have this right. The economically rational thing to do is to make a claim to land, and the way to do that is to cut down the trees, because that, according to the law in many tropical countries, is what constitutes “making the land productive”. Each man is locked into a system that compels him to cut down more forest. This is hardly a traditional cultural trait, but is rather an example of human response to the global culture of acquisitiveness.

Tolerance of corruption is also a cultural trait. Bribery and corruption are severe problems because forest resources are often controlled by a few powerful individuals or clans that regard logging as an opportunity for personal enrichment. In the Philippines, for example, it is common knowledge that President Marcos’ family acquired extraordinary wealth by selling logging concessions to foreign companies (Stone and D’Andrea 2001).

4.2.2.5

Demographic

Increases in population result in increasing pressure to open up forested lands to agriculture. The increases can come from high population growth of settlers already in the region or from migrants from overcrowded cities (Castellanet and Jordan 2002). Sometimes such migrations are subsidized by governments responding to pressure to open up forested areas as a relief valve for overcrowded regions of the country. The opening of the Trans-Amazon highway in Brazil was motivated in part to give drought-stricken farmers of Brazil’s northeast access to Amazonian lands. The Indonesian Transmigration Program described in Box 4.1 is also an example. Migrations also occur when small farms in one region of the country are appropriated by corporate agriculture, and the newly landless farmers must be resettled. For example, the migration of landless farmers to Rondônia in the western Amazon was prompted by the development of soybean mega-farms in southern Brazil (Jordan 1995b).

4.2.3

External Debt and Deforestation

Just as the proximate causes of deforestation do not operate in a vacuum, but rather are stimulated by underlying causes, so the underlying causes do not just appear of their own accord. They result from the desire of “lesser developed countries” (LDCs) to become developed, and from the loans extended to the LDCs by developed countries to facilitate this process (Fig. 4.1). Once the LDCs step onto the development/external debt treadmill, there is no getting off. It has been a vicious cycle with development resulting in debt, and the only way to relieve the debt has been through more development. In the 1970s and 1980s, many developing countries overborrowed relative to their ability to repay the debt. In some countries, debt service obligations have been so large that they exceed new loans and private external investment. External debt resulting from importation of international goods can be considered to be the principal cause of deforestation in developing tropical countries (Kahn and McDonald 1995), in as much as the development needed to repay the debt stimulated the underlying causes of deforestation, which in turn drove the proximate causes.

Many different options are available to a country to deal with its debt problem, such as debt rescheduling, debt repudiation, increased borrowing, and restricting imports and increasing exports. One option to repay debt for a country with large areas of tropical forests is to cut down the forest and export the timber. Each 1 million US dollars in external debt was associated with 8.4 ha of deforestation in Asia and 27.2 ha of deforestation in Latin America (Dorman 2003).

Liquidating forests is very attractive to governments, because removal of forests does not show up on a nation’s system of national accounts. The forest is not considered to be capital, therefore its removal is not counted as loss of capital (Jordan 1995b). It is as if this resource were free. Because the forest resource is considered a “free good”, it is usually used in a non-optimal way, that is, used wastefully. This failure of the national economic system to value resources leads to impoverishment of the resource without the government and the international banks and lending agencies ever becoming aware of the impoverishment.

It is inconsistent that the United Nations’ System of National Accounts (Repetto 1992) considers the depletion of oil as a nation’s capital depletion, but does not consider removal of forests as any type of depletion. This may be a legacy from the outdated consideration of resources as either “non-renewable” (for example, oil) or “renewable” (living resources). However, it is very unlikely that tropical forests are renewable, because the scale at which they are being cut down eliminates the mechanisms that enable them to be renewed.

4.3

Effects of Deforestation

Chapter 1 presented the values of forests in terms of timber resources and fuelwood. It also referred to non-timber tropical forest products such as pharmaceuticals, fibers such as rattans, and foods such as Brazil nuts. Also discussed were non-market values of tropical forests such as preservation of biodiversity, regulation of climate, carbon sinks, indigenous cultural knowledge, and esthetics. All of these values are affected as a result of deforestation. Chapter 2 showed how deforestation results in the loss of productive potential of the soil, as a result of nutrient loss following destruction of the nutrient-conserving mechanisms of the intact forest. Here, we present case studies of the impact of deforestation on the environment, and on the people that live in and around tropical forests.

4.3.1

Environmental Effects of Deforestation

Chapter 1 discussed in detail the most important environmental values of forests: preservation of biodiversity, regulation of climate, and carbon sinks. We place emphasis on the numbers of species in tropical forests and how deforestation is causing species extinctions. The effects on climate were also discussed at both the regional and global levels; for the regional level, we discussed the influence of large extensions of tropical forest on the hydrologic regime, and effects of deforestation on rainfall. For the global level, we discussed one of the most important roles of forests, the absorption of carbon from the atmosphere, thereby reducing the atmospheric buildup of carbon dioxide.

Other environmental effects of deforestation refer to changes at the landscape level, including transformation of the landscape from forest into scrubland, with resulting soil loss, siltation of rivers, and effects on wildlife. Forest cutting due to mining of resources leads to environmental degradation due to forest destruction and to contamination of waters and air as a result of the mining activities. The development of iron mines in Carajás, Brazil (Box 4.2) is a case in point.

Box 4.2

Iron mines in Carajás, Brazil (de Almeida 1986; Hall 1989; Barbosa 2000; Carl Jordan, pers. observ., 1987–1989)

The 1964 military takeover in Brazil marked a turning point in policy-making for Amazonia. Until then, public initiatives to exploit the region's resources had been piecemeal, narrowly focused, and inconclusive. Possibly because the military authorities were more sensitive to the geopolitical importance of integrating the Amazon Basin into the national economy, a new and more aggressive development strategy began. There were Brazilian nationalist fears over the intentions of suspected predatory foreign interests toward Amazonia. There was also the desire of some planners to open the region as a relief valve for peasants from northeastern Brazil, suffering from periodic droughts and an unequal land tenure system that forced them off the land.

While many projects were included in the new development strategy for Amazonia, including the Trans-Amazon highway, the Greater Carajás Program was the largest comprehensive development scheme ever undertaken in an area of tropical rainforest. It was officially inaugurated in 1980, 13 years after the largest known high-grade iron-ore deposits in the world were discovered in a region inhabited mainly by rubber tappers, Brazil nut collectors, and indigenous tribes. The project was based on export-oriented mineral exploitation and associated industrial activities to generate a trade surplus and help service the country's mounting debt. Loans for the project came, in part, from European and Japanese banks, and were tied to a contract that guaranteed 13 million tons of iron ore to be delivered annually to foreign smelters. To deliver the ore from the mines to the shipping port of São Luis on the coast, 900 km of railroad was built that carries trains having 160 freight wagons several times a day.

Part of the plan was to begin processing of the ore in Brazil itself, and so some 30 pig-iron smelters and industrial plants were planned near the railroad. To supply charcoal for the iron-ore smelters, 1,800 km² along the railroad was to be set aside for eucalyptus plantations. Another major part of the project was the construction of a hydroelectric dam on the Tucuruí River, to supply power for processing the 2.2 billion tons of bauxite reserves in the region. Although there was a delay of several years, while Japanese and American interests competed for control of the project, eventually an accord was reached to share the operation with a Brazilian company, and the project began operation in 1984.

While mining was the core of the project, agricultural, livestock, and forestry enterprises extended the project out over 900,000 km², the size of Britain and France combined. The Carajás Program transformed the social and economic landscape of the region. It attracted into eastern Amazonia

thousands of construction workers in search of employment, gold panners in search of riches, small farmers in search of land, ranchers in search of pasture, and speculators in search of quick profit. Local towns have experienced population increases of 400–800%. Competition for land has led to violence. Ranchers and speculators who supposedly bought huge tracts from the government hired gunmen to drive off indigenous peoples and small-scale farmers who had previously claimed the land. The range wars have continued into the beginning of the 21st century. The consolidation of land holdings has resulted in worsened food security. In the towns there is urban poverty, high levels of unemployment, infant mortality, and malnutrition. The 1 million tons of charcoal required to fuel the local smelters require the removal of over 5,000 ha of forest annually. According to the 2004 website of the company that manages the mine, Companhia Vale do Rio Doce (<http://www.vale.com.br/>), they are now searching for ways to protect the environment and the indigenous communities, and have established a community relations program in education and social welfare. However, the company does not have authority over the Greater Carajás region, that is, the land surrounding the mine, railroad, and hydroelectric facilities. It is not clear to what extent deforestation is still occurring in the Greater Carajás region, but social conflict is still rampant. As of 2002, a trial was still underway for 155 military police who surrounded 1,500 rural workers who were encamped in the Municipality of Eldorado do Carajás near the mines and killed 19 and wounded 69 of them (<http://www.labournet.net/world/0106/mst1.html>, <http://www.mstbrazil.org/action030102.html>). Although the Carajás project may result in short-term economic gains by industry, the ecological and social consequences of this pattern of forest use will be catastrophic. The combined effects of industrial, agro-livestock, and lumbering activities are turning a large part of eastern Amazonia into an unproductive scrubland, leading to soil erosion, compaction, leaching, a greater frequency of flooding, siltation of rivers and dams, pasture degradation, and atmospheric pollution.

4.3.2

Social and Economic Effects of Deforestation

4.3.2.1

Effects on Indigenous Peoples

Many of the development projects that began in the years after World War II gave little thought as to how such projects would affect local populations, other than assuming that they would benefit. While attitudes in development agencies have changed in recent years, the belief still remains that indigenous

peoples can adapt quickly, once they are presented with the benefits offered by developed societies. The following case studies show that this assumption is not necessarily true (Box 4.3).

Box 4.3**Development and deforestation in the Philippines (Westoby 1962; Jordan 1995 b; Juan Pulhin, cited in Stone and D'Andrea 2001, p. 65; Center for Resources and Environmental Studies 2003).**

In 1962, the Food and Agriculture Organization (FAO) of the United Nations issued a report stating that developing countries had neglected their forest assets that could be converted into powerful engines for economic advancement. Harvesting these resources more aggressively, said the report, would result in a symbiotic relationship between industrial nations and less-developed countries (LDCs). The LDCs which had abundant forest resources could mobilize them for development, in as much as they could be assured of markets within more advanced trading partners. These more developed countries would also benefit from the relationship through the steady supply of forest products, particularly timber, to fuel and sustain further economic development. This was the prevailing attitude among international development authorities in the 1950s and 1960s. As a result, industrial forestry was undertaken in countries such as the Philippines. Contracts and development plans were administered from the top down, an approach that conformed to the accepted economic developments standards of the time.

Stone and D'Andrea (2001) chronicled the impact of such development on the upland forests of Mindanao, and on the indigenous Lumads who occupied these forests. For centuries, the Lumads lived on the upper slopes of Mindanao in Bukidnon province, in relative isolation. Following World War II, the population of the Philippines exploded, and after the best agricultural soils in the lowlands were occupied, migrants from other islands began moving into Bukidnon. The Lumads fled to more remote areas, because they had no land rights. However, the law of the land allocated these "undocumented" lands to the public domain. The Lumads were considered squatters, and had to move on when a number of foreign logging companies began operating in the province. By the mid 1970s, these companies, and the national ones that eventually replaced them, had stripped Bukidnon of its timber. The companies then moved on to new territories. The number of forest licenses issued to timber companies and the number of hectares felled each year reached a record between 1972 and 1984. By 1990, only 20% of the country was forested, and most of this was second-growth forest with less commercial value or biological importance than the old-growth forest.

Some of the immigrants to Bukidnon were able to establish farms in the cut-over forests, but periodic fires converted much of the land to alang alang (*Imperata cylindrica*), an aggressive grass that competes with crops and that is very difficult to control. The hoped-for benefits of forest-based development had not materialized. Fortunes were made as forests were devastated. However, nearly all the benefits were funneled to those in political power, with practically no benefits to the local farmers (Stone and D'Andrea 2001).

The Tala-andig are another indigenous group that lived in the mountains around the central plateau of Mindanao. Like the Lumads, they were forced to higher elevations as logging companies cleared the valley, once covered by moist forest. Now they live on lands officially claimed as “ancestral heritage”, but the forests still are endangered. Soils cleared of forest at high elevations are ideal for growing potatoes, much in demand in Manila fast-food restaurants. However, they can be grown for only 1 year before suffering from wilt, so the migrant farmers continually move upslope, seeking fresh ground. Forests are opened up through “accidental” fires in alang alang, which quickly spread upslope.

There are many more cases of where governments of tropical countries have granted logging concessions to national or international companies with little thought of how deforestation would affect the indigenous peoples that live in the regions. In many cases, such as that of the BaNgombe and BaKoule of the Congo (Box 4.4), loggers removed only a small proportion of the trees. Nevertheless, the presence of the logging company had a large impact on these people, both economically and socially. In other cases, such as that of the Penan in Borneo (Box 4.5), environmental disasters such as fires resulting from careless logging added to the impact on indigenous peoples.

Box 4.4

The BaNgombe and BaKoule of the Congo

Wilkie (1996) discussed some short- and long-term consequences of commercial selective logging by the Société Forestière Algéro-Congolaise (SFAC) on indigenous BaNgombe foragers and BaKouele farmers of the northern forests of the Republic of Congo. SFAC is a semipublic company formed in 1983 within the framework of a 20-year cooperative agreement between the Democratic and Popular Republic of Algeria and the Republic of the Congo. In 1985, SFAC began selective logging in a concession of 855,000 ha in the Sangha region.

Before the colonial period (1900–1960), the BaNgombe lived a seminomadic existence. They had a long-term exchange relationship with BaKoule farmers who were settled in villages alongside perennial rivers and

streams and practiced rotational slash-and-burn agriculture. The BaNgombe traded farm labor and forest products such as meat and honey for cultivated crops and commodities such as salt, clothing, and tobacco. They traveled in the forest for extended periods of time and hunted forest antelope and primates with crossbow, nets, and traps.

The arrival of SFAC had a profound effect on the local economy. Although the company used heavy machinery to build roads and transport cut logs, the company still had to hire a relatively large number of workers on a daily or monthly basis. The tribal compositions of work teams had clear differences. Inventory and exploitation teams were primarily BaKouele and BaNgombe, because of their intimate knowledge of the area and the tree species. The drivers and mechanics were usually from regions outside the Sangha. Despite their low wages, BaKouele and BaNgombe families with SFAC employees were more likely to have tin-roofed huts, new aluminum cooking pots, eating utensils, flashlights, and new clothes and shoes than those families with no SFAC workers. The logging operation improved health-care services, primary education, and housing conditions for a small portion of the BaKouele who lived close to headquarters. The BaNgombe, however, did not benefit, owing to implicit prejudice in the allocation of worker housing. As a result of the entrance into the cash economy, artisan and hunting skills were lost. SFAC employees used wages to finance commercial wild game hunting by buying shotguns and cartridges.

Although SFAC logging spurred the local economy and enhanced the material quality of life for BaKouele and BaNgombe employees, its effect on social services was very local. In addition, the economic income was unlikely to last, as the concession was only for 20 years, at which time most of the valuable timber in the area will have been taken. In the conclusion to his paper, Wilkie (1996) asked: "How will five to ten years or more of high income affect the needs, aspirations, and social behavior of a given local population of BaNgombe and BaKouele? Will today's employees be able to return to a more basic lifestyle once SFAC moves out of their region? Will they be able to re-attain traditional sharing patterns? Will young people have neglected to learn traditional techniques that once again become more important to daily subsistence? Will the state be able to assume the role of education and health care provider once SFAC moves out of an area? Will faunal populations be able to recover from such intensive market hunting and thus continue to provide the local population with a necessary source of protein?"

For the BaNgombe and BaKouele, the long-term costs may outweigh the short-term benefits.

Box 4.5**The Penan of Borneo**

During the 1980s and early 1990s, Dr. J.P. Brosius conducted research among the Penan, an indigenous group that has inhabited the interior of the Malaysian state of Sarawak. One of the objectives of his work was to characterize how the government was able to overcome the resistance, not only of the Penan themselves, but also of international environmental organizations, to deforestation of the Penan homeland (Brosius 1995).

The natural landscape cover of Sarawak on the island of Borneo is moist forest. For the Penan, the landscape has been more than simply a reservoir of detailed ecological knowledge or a setting in which they satisfied their nutritional needs. A strong coherence has existed for them between the physical landscape, history, genealogy, and the identities of individuals and communities. Rivers were the paradigm around which spatial, historical, and genealogical information was organized.

The Penan were migratory, and the factor that more than any other determined their movement was the availability of the sago palm, *Eugeissona utilis*. Sago has been the principal source of carbohydrate for the Penan. Trunk sections were split, and the pith was pounded, rendering it soft and pliable. The pith was then placed in baskets and trampled by women, while pouring water through. The starch was separated from the pith by the trampling, and it washed through into the settling mat below.

Sago can be harvested sustainably. It reproduces vegetatively if the roots are left intact. When the sago in one area was depleted, the people moved to another area, leaving the previous stand to recover. The Penan ethics of resource use was one of explicit stewardship. Leaves of other palms were used for weaving. Women were the exclusive weavers for the Penan. Their mats and baskets were in great demand by other groups who in turn traded with Chinese merchants.

Penan hunters used blowpipes for small game such as monkeys, squirrels, and barking deer. For their blow darts, they used poison extracted from a local tree. For larger game, dogs were used to chase and corner the prey until it could be speared by a hunter. The favored game was bearded pig, not only because of its large quantity of meat, but also because of its substantial deposits of fat that could be rendered and stored for later use.

The first signs that the sustainable coexistence of the Penan and forest was ending were the survey markers for logging tracts. By 1992, a bridge and logging road had driven the game out of the Seping River Valley in the center of the homelands, and clogged the river with mud. Clearing of the forests changed the perspective of the rivers to the Penan. The cultural symbols were no longer recognizable. Hunting grounds were destroyed, as well as ancestral burial grounds. Trees that had little market value were

cut and discarded, even though they had great value to the Penan for making tools and blowpipes.

The Penan responded by erecting symbolic barricades in the forest. Their protests attracted the attention of international organizations such as the Rainforest Action Network, who organized a series of blockades that galvanized global concern. The Malaysian government responded in various ways. One was to trivialize the issue. They acted toward the complaints as one would act toward the complaints of wayward children. "Authority knows best, and what it does is for the good of those disciplined". This attitude was especially apparent in the bemused and contemptuous attitude of loggers toward the Penan when they encountered them in the forest. The government did begin programs to help the Penan, such as giving them sheets of plywood for their shelters. For the most part, however, the government rejected emotional scenes by claiming that the scenes were instigated by "imperialists". The Sarawak chief minister summed up the government's attitude as follows: "How can we have an equal society when you allow a small group of people to behave like animals in the jungle... I owe it to the Penans to get them gradually into the mainstream so that they can be like any other Sarawakian".

In 1992, the Earth Summit meeting in Rio de Janeiro called for the world's greater attention to complaints of indigenous groups such as the Penan. The Manila-based Asian Development Bank (ADB), which since 1977 had been making forestry loans, accordingly began to develop new policies with more environmental safeguards. Its 1995 forest policy paper stressed "the need to balance the three imperatives of production, protection, and participation". As a result of this policy, there began an effort to include the participation of local peoples in plans for the forest. However, the paper did not rule out bank support for plantations and production forestry.

In 1997, smoke from the fires in Borneo clouded skies, closed airports and entire communities, and provoked complaints from as far away as Singapore and Kuala Lumpur. London's *Sunday Times* classified the disaster as "wholly man-made" – because many of the hundreds of fires were started deliberately as a cheap way to clear land by companies with corrupt connections to government officials. Shortly thereafter, the Asian Development Bank's principal environmental officer admitted in an interview that "we are still evolving our strategies for participation" (Stone and D'Andrea 2001).

Costs and Benefits

There really are no real benefits to indigenous peoples as a result of the deforestation of the land in which they live. Often, they are paid small sums of cash by the government or by the corporations that take their land, but, soon afterward, both the forests and the money are gone. Sometimes the tribes are moved to another area, but almost always their situation will deteriorate, either because they are not familiar with the environmental situation or because they come into conflict with other groups that are already there. In some cases, the people migrate to cities where they live in urban slums, because they do not have the skills to compete in the modern economy, or because the cities are not prepared to absorb the extra manpower or to provide adequate living conditions for the migrants.

In recent years, some indigenous groups have learned to use the tactics of the antiglobalization movement to agitate against national policies that they see as destructive to their environment and culture. For example, in the south of Chile, the Mapuche Indians have become major political players fighting timber companies who want to exploit the ancient forests that constitute their tribal homelands. In Bolivia, radical Indian leaders seized upon a dispute over tribal justice to mobilize thousands of protestors. They blocked roads and laid siege to La Paz. As a result, the president, Sanchez de Losada, fled into exile in the USA (de Cordoba 2004) and on 17 October 2003, Carlos Mesa assumed the presidency of Bolivia.

4.3.2.2

Effects on Traditional Rural Peoples

The effect of deforestation upon traditional rural peoples is much the same as that upon indigenous peoples. Both have lived in the forest for generations, have come to depend upon the forest for their livelihood, and have practiced management that while not always ecologically sound, nevertheless did not destroy the regenerative and productive capacity of the forest. Deforestation in India (Box 4.6) serves to illustrate this point.

Box 4.6

Deforestation in India

Alcorn and Molnar (1996) described the conflict arising from deforestation in India. As in most developing countries, deforestation affects two interest groups: commercial interests and subsistence interests. The commercial interest group has used forests to generate capital, as if nature were just another asset to be converted into some other capital asset without penalty. On the other hand, members of the subsistence interest group view forests as the base of their support. Destruction of the forests means the end of their benefits.

Through its rules, policies, and price supports designed to promote industrialization, as well as through budget allocation and economic analyses, in India the state has generally supported the commercial interests allied with the political elites. Those dependent on nature for subsistence have exercised little political power. Although Indian communities have long fought to retain or regain rights to make decisions about forest management, the state has usurped their rights in the name of modern management and conservation.

The subsistence base of three major sociopolitical groups in India has been particularly affected by this progressive loss of rights and alienation from forest management: pastoralists, tribes, and sedentary farmers. Pastoralists are largely dependent on open woodlands for fodder to supplement pasture. Tribes in India have been concentrated in the hill forests, especially at the northeastern border with Myanmar and China. Tribal cultures had the most rules regarding forest management, ranging from re-planting to the maintenance of sacred groves. The third group is sedentary non-tribal villagers who depend on forests for fodder for their livestock, for cooking fuel, for timber, and for non-timber forest products. This group has had the most success in resisting usurpation of their forests, in part because of the Gandhian tradition of peaceful resistance and a religious tradition that values peace for all living organisms. The "Chipko" movement, in which women hugged trees to keep them from being felled for commercial use, began in 1972 and in 1981 achieved a ban on commercial deforestation in an area of 40,000 km².

Nevertheless, deforestation continued to be a major problem in India in the 1990s. In the industrial sector, shortages of raw materials and obsolete equipment caused forest-based processing enterprises to operate at a fraction of their capacity. The demand for pulp, paper, and manufactured wood products spiraled as urban and middle-class incomes rose and consumer demands for wood and paper products increased.

Beginning in the 1970s and 1980s, there have been efforts to combat deforestation. Almost all the Indian states have had extensive afforestation programs to meet the rising demand for forest products and to help check deforestation. Social forestry programs have been implemented following Gujarat Forest Department's experiments with community woodlots in the 1970s. In 1976, the National Commission in Agriculture recommended a national social forestry effort, and government, bilateral donors, and multilateral development banks funded it. They were originally directed at the fuelwood crisis, but have evolved to supply all types of forest products. Evaluations of the program have been varied, depending on the criteria used. While industrial supply of wood or pulp has in some cases met the needs of industry, social equity issues have fared less well. In many cases,

poor people were hurt when common property resources were closed to them in order to create plantations whose products have mainly helped those already rich. On the other hand, social forestry programs have frozen the common property status of land, and thereby prevented further privatization.

Hundreds of grassroots groups have arisen in India, and their concern is with conserving the environment for the benefit of local communities. These groups are not concerned with environmental protection per se, but with the proper use of the environment and who should benefit from it. For example, the vision of the “Centre for Science and the Environment” [a major non-governmental organization (NGO) based in New Delhi] calls for each rural settlement in India to have a clearly and legally defined environment to protect and improve.

Over the past few years, there has been a marked change in the Indian economy, as a result of the globalization of some service industries. High-tech firms such as IBM are now setting part of their operations, such as software programing, in India as well as in other developing countries where wages and others costs are much cheaper than in industrialized countries. Medical centers in the USA are relying on medical doctors in India to process data. Many less skilled Indians are manning call centers as service representatives for US corporations (Irwin 2004). Many young people are being trained in telephone etiquette and to speak with regional accents, depending upon where the incoming call originates. These young people are breaking away from tradition, and are increasingly involved in the global economy. The transformation in India has been remarkable. “India has shifted away from socialism and dived headfirst into global trade, the information revolution and turning itself into the world’s service center” (Friedman 2004). Whether the new service economy will replace the older extraction economy on a scale to reduce the problem of deforestation and environmental degradation remains to be seen.

4.3.2.3

Effects on Recently Arrived Rural Peoples

Tropical forests and the soils that sustain them represent natural capital, that is, they are a resource that required no human effort to establish. When natural capital becomes available to anyone for the taking, there naturally will be a rush to establish a claim on this open-access commons. The arrival of farmers in the Amazon and the consequent agricultural development in this frontier region (Box 4.7) illustrate the phenomenon.

Box 4.7**Agricultural development by migrant farmers in the Amazon**

Before the 1970s, the land around the river village of Altamira on the Xingú River (a tributary of the Amazon) was completely forested, and was occupied only by indigenous tribes and by sparse caboclo (descendants of indigenous and white people) populations along the main river who lived by fishing and rubber extraction. Altamira was the center of public agricultural colonization, opened by the military government in 1972 through public subsidies and government-planned centralized programs. The population grew rapidly during the 1970s, owing to government incentives and propaganda (the public slogan was “Amazonia: a land without men for men without land”). However, the number of farmers who actually settled was much lower, and the costs per farmer much higher than the very optimistic initial forecasts. A large proportion of the farmers, disillusioned with the lack of infrastructure and the low fertility of the soils, abandoned their land after a few years, but were replaced by newcomers, mostly landless migrants from northeastern Brazil. After a few years of poor results, government support was reduced (Moran 1981, 1996). However, the flux of migrants into the region continued spontaneously during the 1980s and early 1990s and later decreased gradually.

In the 1990s, LAET (Laboratório Agro-Ecológico de Transamazônica, or the Agroecological Laboratory of the Amazon region, an NGO funded in part by the European Union) began a project in the region around Altamira to encourage farmers to improve their methods of natural resource management, thereby reducing deforestation (Castellanet and Jordan 2002). As part of their work, LAET members carried out a survey in the Altamira region to characterize the farmers of the region, including their economic status.

In contrast to the impact of deforestation on traditional farmers in India, it could be said that deforestation in the Altamira region actually helped farmers, in that it opened up new lands to be exploited. The critical difference from India is that the Brazilian farmers were not from the region deforested, but rather from other parts of the country. The LAET survey (Table 4.5) suggested seven different categories to characterize farmers:

1. “Just arrived” farmers were those who lived on the land for 4 years or less. The long distance from all-weather roads made it very difficult to market products, and, as a result, profitability was low.
2. Pepper producers did not do especially well, in part because of problems with wilt, a fungal disease caused by *Fusarium*.
3. Of all farmers, cocoa producers were doing best at the time of the survey, but cocoa prices are cyclic, and income was not continually maintained.

4. Some farmers actually were losing some of their original investment ("losing capital").
5. Farmers who diversified (cacao + cattle) were able to maintain themselves relatively well.
6. Cattle producers who had enough capital to improve their pastures or to continually acquire new land for new pastures maintained themselves.
7. Small-scale ranchers (glebistas) who were forced to maintain their herds on pastures that were rapidly losing fertility did poorly.

Despite the government's promise that new lands would provide wonderful opportunities for farmers who would settle the Amazon, the new lands actually benefited the farmers relatively little from an economic standpoint.

After 5 years, LAET researchers concluded that the main problem of resource conservation was not soil fertility, but the extension of poorly managed pastures. As a result, they suggested that a better strategy for the region would be to encourage more intensive management of smaller-sized holdings. A comparison of social and economic factors for farmers with land holdings of different sizes suggested that 25–35 ha should be sufficient to maintain or even increase the level of agricultural production, based on the following cycle: 2 ha of annual crops for 1 year, intercropped with leguminous cover crops, followed by 5 years of pasture, and 5–10 years of fallow before a new slash-and-burn cycle.

Table 4.5. Characteristics of farmers interviewed in the 1994 Altamira survey (Castellani and Jordan 2002)

Type of farmer	No. of years on the land (ha)	Distance from the road (km)	Income (US\$/year)	Percentage of income ^a				Pasture area
				Cacao	Pepper	Cattle	Rice	
Just arrived	4	32	2,015	0	13	1	20	7
Pepper producer	14	15	3,138	7	25	10	8	23
Cacao producer	15	19	7,990	59	8	5	6	37
Losing capital	13	18	1,219	0	4	3	23	5
Cacao + cattle	15	6	6,962	31	13	28	7	38
Cattle producer	16	6	7,562	8	6	40	4	68
Rancher	11	30	1,489	1	0	60	2	197

^a Other sources of income include small animals, extractivism, commerce, small business, and labor sale (wages)

The Local Elite in Altamira

The overall objective of the LAET (Laboratório Agro-Ecológico de Transamazônica, or the Agroecological Laboratory of the Amazon region) project was to improve management of natural resources, with a specific goal of slowing the rate of deforestation in the region along the Amazon highway near Altamira, a center of colonization. The initial focus group was made up of farmers, since they were suspected of having the greatest impact on natural resource management. However, once researchers began to work with those in forestry and the wood industry, they realized that sawmill owners and large ranchers played a greater role in deforestation, especially when their interests coincided with those of farmers. For example, sawmill owners opened roads or rehabilitated them and encouraged further occupation by landless farmers (*posseiros*) to cover up illegal logging and to provide cheap manpower and logistical support for loggers. For farmers who were already established, sawmill owners arranged for repair of damaged feeder roads and for provision of free rides to the city.

Big ranchers also had common interests with small farmers. Ranchers offered the farmers opportunities for day labor, assistance in transport, and the renting or sharing of cattle. Some small farmers had a strategy of converting their land from forest to pasture and then selling it at a good profit to ranchers. Ranchers who wanted to expand their pastures quickly without having to depend on contracted manpower often depended on buying land from small farmers.

Merchants and service people in small towns also had an interest in expansion of agriculture, since farmers and ranchers were their main customers and providers of commodities. The business community also favored farmers, because their contribution to the population of the region was important in obtaining support from the state and federal government. Such support was based on the size of the county's population.

Because of the financial interest of these local groups in economic expansion, it was difficult for LAET to stimulate interest in concepts such as zoning that would reduce deforestation. However, there was a difference in attitude between business leaders in villages on the upland frontier, where regulations concerning natural resource management were strongly opposed, and long-established river towns where people were more aware of problems of deforestation, and therefore were more sympathetic towards regulations that would preserve forests (Castellanet and Jordan 2002).

4.3.3

Benefits and Costs of Deforestation at the International and National Levels

4.3.3.1

International

Deforestation and development result in benefits for countries and companies that import tropical timbers. These benefits include: increased business for international timber companies; lower prices for wood; employment for value-added industries such as furniture manufacturers; and overall increase in trade that could help industries that export products to tropical countries. Costs might include the widening of the gap between the have- and have-not countries, if prices paid for tropical timbers are lower than the replacement costs. Pricing timber below replacement costs decreases even further the ability of tropical countries to catch up economically with developed countries. Such economic disparities can result in international tension.

4.3.3.2

National

Deforestation to finance development can produce short-term benefits for the developing country. The benefits can include: easing of debt crisis; obtaining currency for foreign exchange; securing national boundaries; attracting international investment; easing of social problems in some overcrowded areas (due to transmigration programs); and increasing political control in frontier areas (benefit for governing party, not for opposition parties).

However, if the prices received for exported timber are below replacement costs, the solution to debt crisis will only be temporary. Loss of natural capital precludes long-term solution to economic ills; delays long-term solutions to economic problems; increases social problems on the frontier; increases environmental problems; and increases obligations to transnational corporations that may not be in the best national interest.

4.4

Conclusion

Although the rate of deforestation in the tropics is debated, the overall trend is clear. The world is experiencing a significant loss of its tropical forests. The data in Table 4.1 (total forested area divided by area deforested annually) suggest that if the rate does not slow, tropical forests will have disappeared within a time frame of a century. The law of supply and demand predicts that as tropical timber becomes scarcer, its use will become more efficient, and,

as a result, the rate of forest depletion may slow. The problem is that, by the time this occurs, the ability of tropical forests to reproduce may be seriously impaired.

As tropical forests disappear, the productive potential of the land is affected, as are local and national economies. For some groups, the adjustments will improve their economic income, while for others their situation will deteriorate. For everyone, there will be a loss of an international treasure of immeasurable value.